Palaeogeographic maps of Moscovian and Artinskian; contributions from the Netherlands

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ABSTRACT

Frequent marine bands in the early Westphalian of the Netherlands are replaced by peat marshes followed upwards by a braided-river/fluvial-plain system in the late Westphalian-Stephanian. Sediments are limited to the depocenters Stephanian. Asselian to Artinskian deposits are represented by Lower Rotliegende volcanoclastics, basaltic volcanics and sediments of continental environment.

KEY WORDS
Westphalian,
Stephanian,
Lower Rotliegende,
Variscan front,
basins,
tectofacies.

RÉSUMÉ

De nombreux niveaux marins du Westphalien inférieur des Pays-Bas sont remplacés vers le haut par des tourbes marécageuses suivies par des systèmes fluviatiles de plaine deltaïque au Westphalien supérieur-Stephanien. Les sédiments stéphaniens sont limités aux dépôts-centres. Les niveaux de l'Asselien à l'Artinskien sont représentés par des volcanoclastites du Rotliegende Inférieur, des basaltes et des sédiments d'environnement continental.

MOTS CLÉS
Westphalien,
Stéphanien,
Rotliegende inférieur,
front varisque,
bassins,
tectofaciès.

MOSCOVIAN TO GZHELIAN

The Moscovian deposits are represented, according to the current ideas, by approximately the interval of the Westphalian C to Stephanian. The constraint is provided by the age dating of Lippolt *et al.* (1984), which revealed an age of 311 Ma for the base of the Westphalian C. The exact chronostratigraphic position of the youngest sediments (? Stephanian) in the eastern Netherlands and adjacent part of Germany is still debated, since the palynological assemblages clearly indicate a younger age (Autunian) than the paleobotanical assemblages (Westphalian D; Van der Zwan *et al.* 1993). There is a tendency in Germany to place these sediments in the youngest part of the Carboniferous, the Gzhelian (Plein 1995). During the Moscovian, an important change in climate occurred from humid tropical conditions to a (semi-) arid climate, as documented by a change in soil type (Selter 1989; Van der Zwan *et al.* 1993).

In broad terms, the development of the Westphalian C to Stephanian deposits is quite similar throughout the onshore and offshore areas; the main difference consists of the amount of later erosion of the Carboniferous. For the Netherlands, one reference section has been compiled for the eastern Netherlands (Fig. 1).

The present-day outline of the Moscovian deposits (Fig. 2) in the Netherlands is mainly controlled by erosion and uplift owing to the Variscan deformation phase during the youngest Carboniferous. In large part of the Netherlands onshore and western offshore areas Bashkirian (Westfalian A/B) deposits underlie the Permian rocks. Compared to the Westphalian A and B, the younger Westphalian and Stephanian have been deposited under increasing tectonic instability as the Variscan front prograded northward. This resulted in the intermittent tectonic activity of main fault zones, and at the end of the Carboniferous led to the deformation of the foreland-basin infill. The Variscan phase is considered to have accentuated the differences in subsidence during the Moscovian. In the basins, up to 1200 m of Westphalian C to Stephanian sediments have been preserved; in the uplifted areas, sediment thicknesses of this interval were probably not over 750 m and presumably consist of fine-grained sediments.

At the onset of the Westphalian C, extensive peat marshes existed over the entire Netherlands offshore and onshore areas. Marine bands, which frequently occurred in the Westphalian A and B, occured only sporadically in the Early Westphalian C. During the late Westphalian C, owing to an abrupt influx of coarser grained sediments, these marshes were replaced by an extensive braided-river/fluvial-plain system. Sediments came basically from three different source areas, the Rhenish Massif in Germany in the southeast, the Mid North Sea High in the north, and the Brabant Massif to the south (Fig. 2). There are minor differences in the onset and duration of these sandy influxes between the different parts of the basin. These sandy sediments were replaced in the early Westphalian D again by fine-grained sedimentation. The only exception is formed by the Campine Basin in north-eastern Belgium and the south-eastern Netherlands, where the sandy fluvial deposits are limited to the early Westphalian D interval (Paproth *et al.* 1983). In other areas, during the Westphalian D deposition took place on a semi-arid flood-plain with sheet floods and braided rivers. Soil types indicate that these flood-plains became better drained during this timespan.

The occurrence of the ? Stephanian deposits is limited to the depocentres of the Moscovian basins in the eastern Netherlands and probably the northern Netherlands offshore area. An unconformable contact of the Stephanian with the underlying Westphalian D sediments is assumed (Tantow 1993; Van Adrichem, Boogaert & Kouwe 1993-1996). Stephanian deposits are formed by well-drained distal floodplain deposits, with minor braided channels (Van der Zwan 1993).

ASSELIAN TO ARTINSKIAN

The Asselian to Artinskian deposits in the

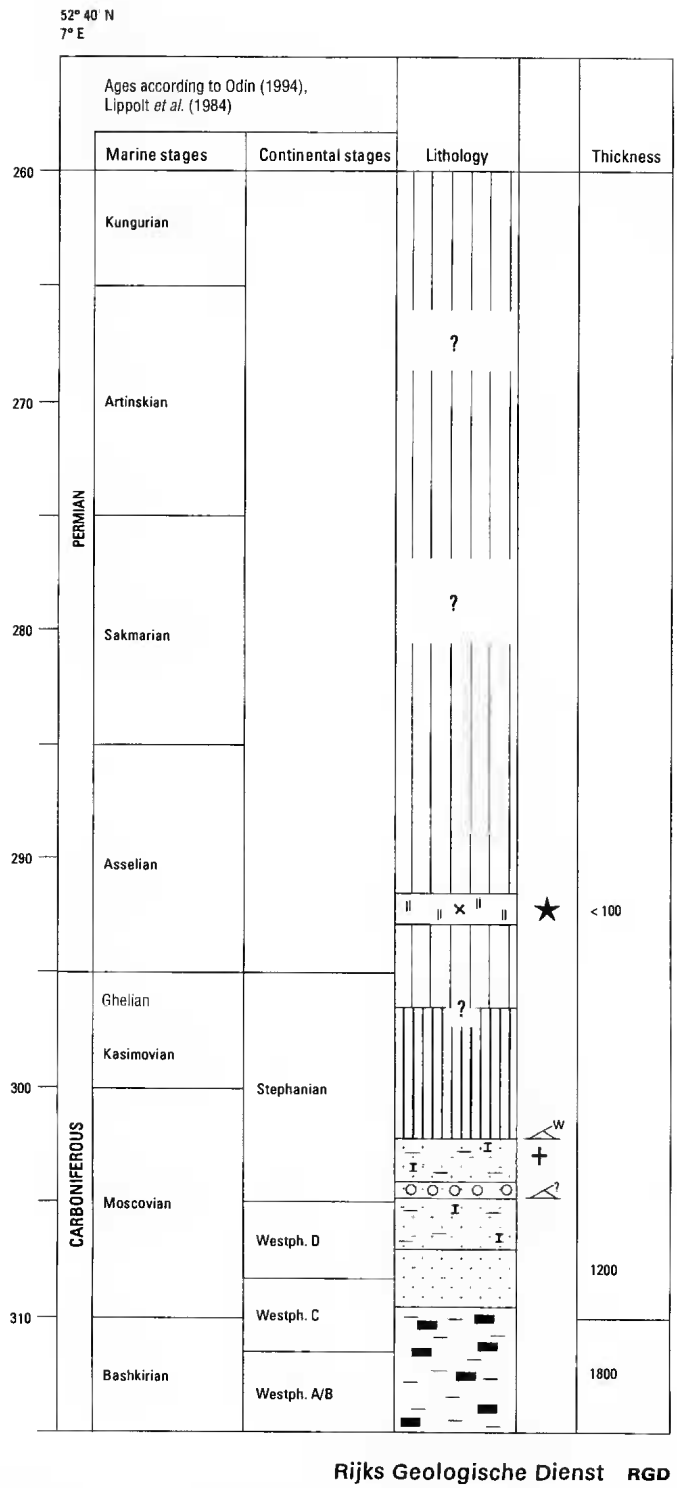

FIG. 1. — Reference columnar section for eastern Netherlands. See Vai & Venturini (this volume) for legend.

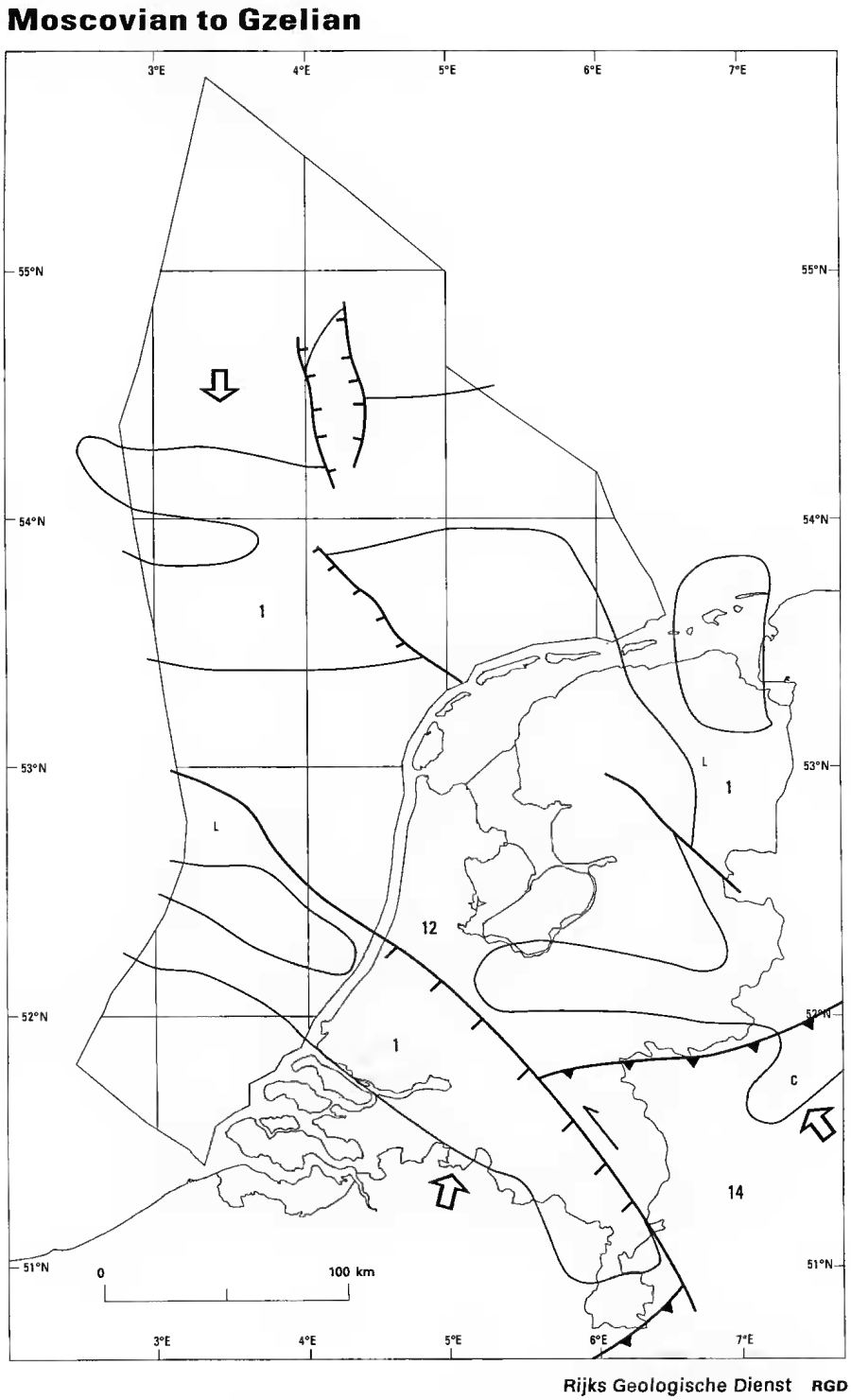

FIG. 2. — Deposits of Moscovian age in the Netherlands. See Vai & Venturini (this volume) for legend.

Asselian to Artinskian

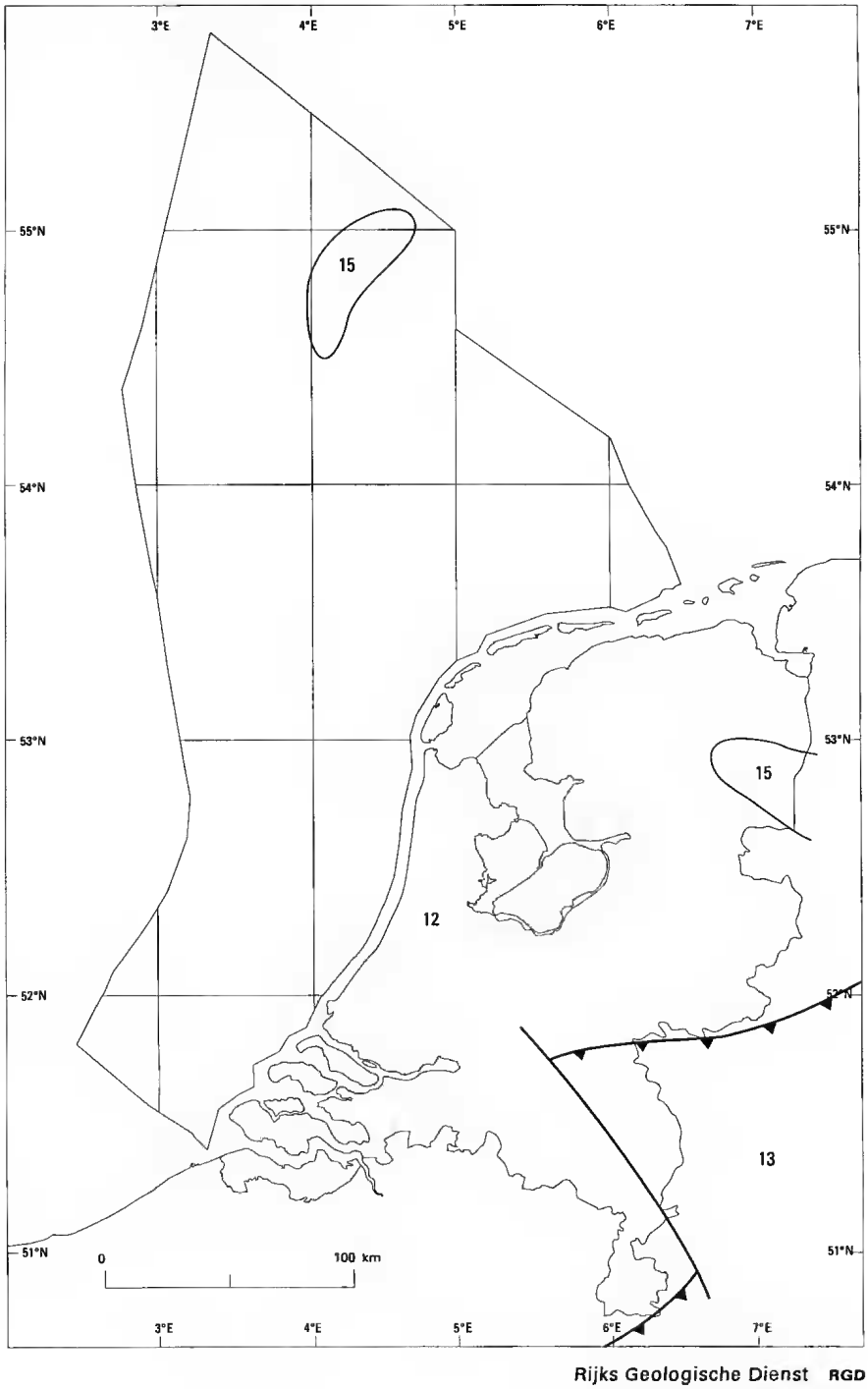

FIG. 3. — Lower Rotliegende volcanoclastics of Asselian to Artinskian age in the Netherland onshore and offshore areas. See Vai & Venturini (this volume) for legend.

Netherlands are represented only in small areas of the Netherlands by sediments. The deposits of this interval are most likely represented by the Lower Rotliegend volcanoclastics. These volcanoclastics occur in two separate areas, namely in the Ems Low in the eastern Netherlands onshore area and the Central North Sea Graben in the offshore area (Fig. 3). Volcanic activity in the Netherlands and Germany occurred in response to wrench movements along Variscan fault zones (Ziegler 1990).

The volcanoclastics in the Ems Low represent the western outliers of a more extensive area of volcanic activity in Germany (Plein 1995). The volcanoclastics consist of red-brown to green spilitic, basaltic volcanics and mudstones. Several stacked lava flows occur in the succession. The thickness of the volcanics reaches a maximum of 80 m. The age remains speculative, but, based on indirect evidence, is assumed to be Asselian (Plein 1995).

In the Central North Sea Graben the sequence reaches a thickness of almost 150 m. The volcanics consist here of massive tuffs and lavas up to several tens of meters thick, interbedded with claystones and subordinate sandstones. No reliable datings are available for these volcanics (Plein 1995). They are assumed to have an Asselian age.

Following the Asselian, a long period of non-deposition followed; sedimention was only resumed during the youngest stage of the Permian, the Tatarian.

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